AuScope Simulations for 3rd SLR Site in Australia

Erricos C. Pavlis, Dan MacMillan and Zuheir Altamimi

GGOS Ground Networks & Communications WG,
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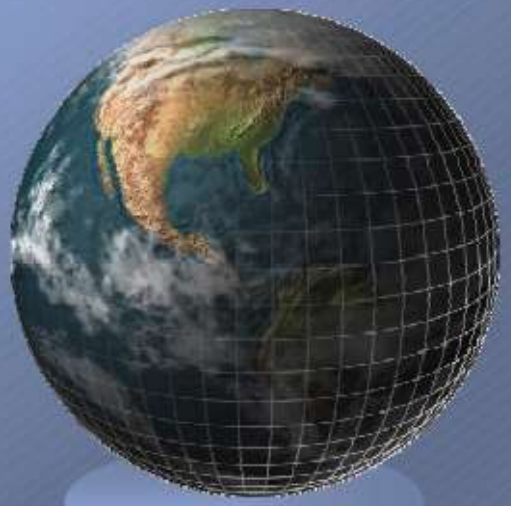
Introduction

- The Australian government approved a large scale Earth science project similar to USA's EarthScope, under the name AuScope
- The GGOS GNC WG was approached by Geosciences Australia and AuScope scientists, to provide input for optimal selection of an additional SLR site co-located at one of the new VLBI sites

AuScope

National Collaborative Research Infrastructure Program



An initiative by the Federal Government to inject ~550million AUD into research infrastructure over 5 years

After a call for proposals across all science disciplines 16 were selected for further development.

AuScope: Structure and Evolution of the Australian Continent.

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

AuScope

- The current plans (**AUS$15.8 awarded**) for infrastructure improvement include:
  - 3 New VLBI Antenna (Mt Pleasant, Yarragadee, and Katherine (North Central Australia))
  - VLBI software correlator
  - 1 Absolute gravimeter
  - 1 Tidal gravimeter
  - a Multi pier gravity calibration facility (Mt Stromlo)
  - upgrade to the laser power at Mt Stromlo for more effective MEO ranging
  - FTLRS campaign at Burnie (Tasmania) for altimeter calibration
  - Approximately 110 new GNSS sites

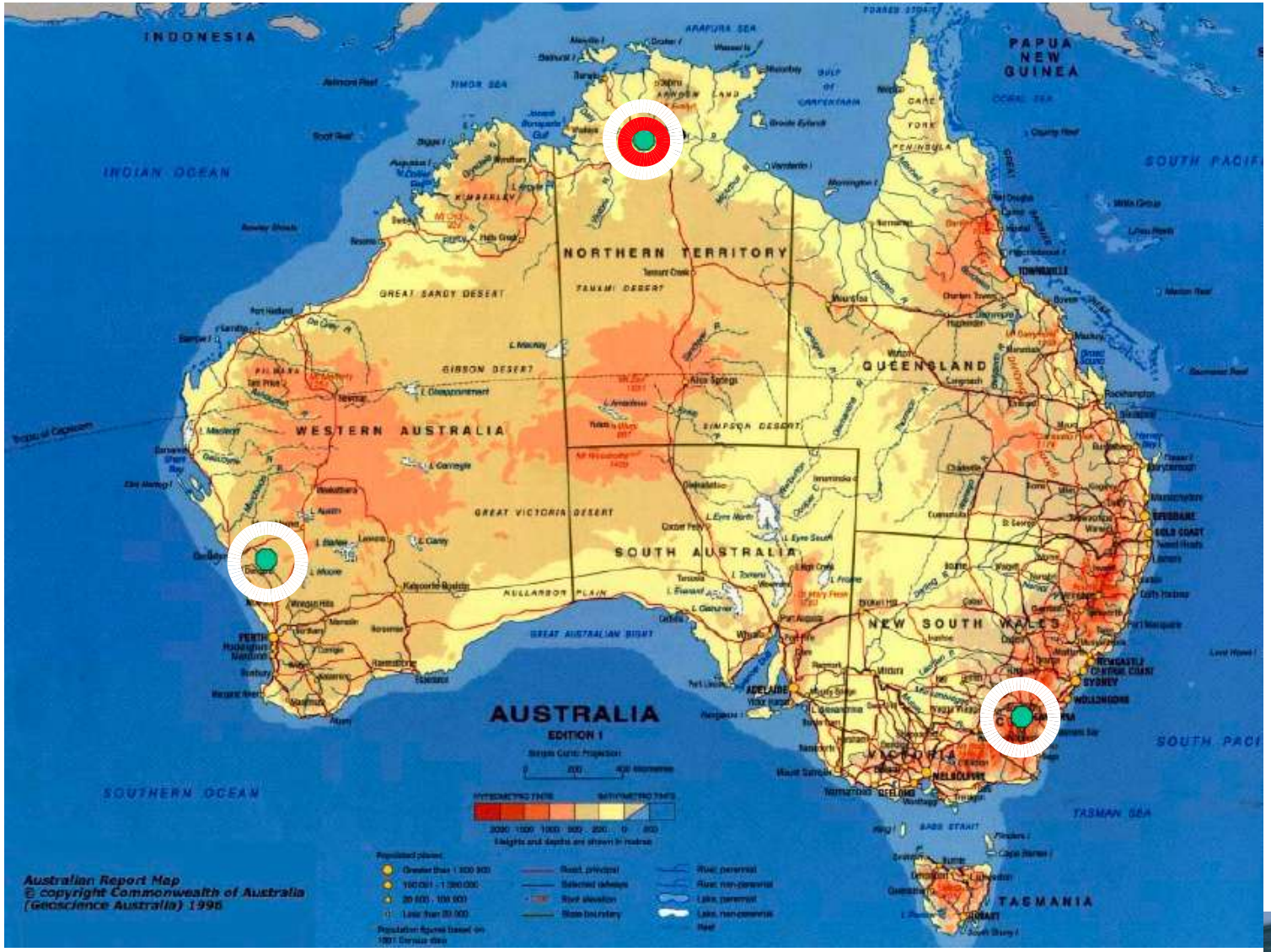
Add new (3rd) SLR or not?

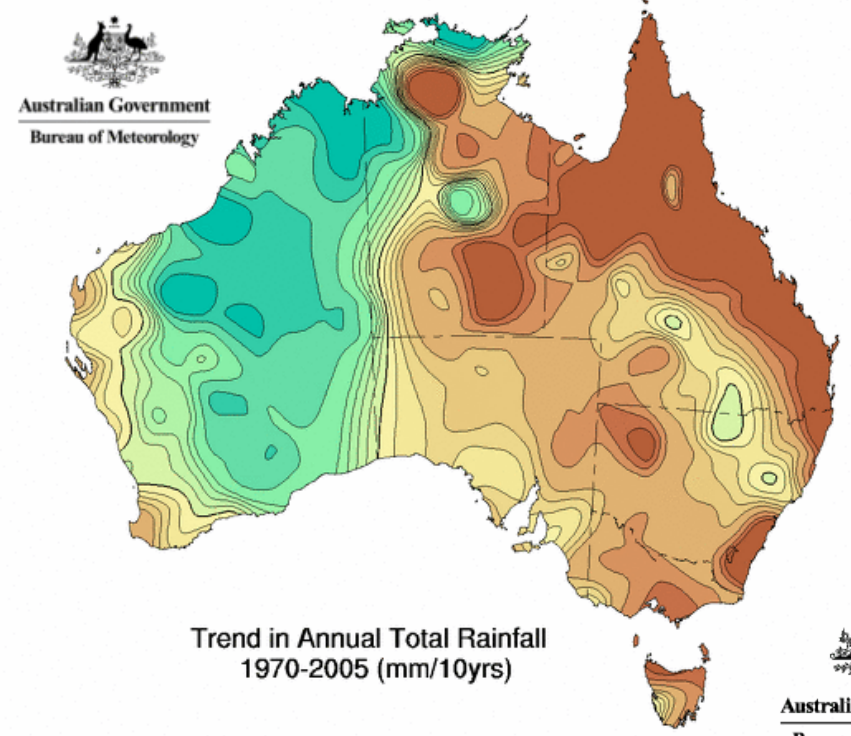
Is there a compelling need for a third SLR system?

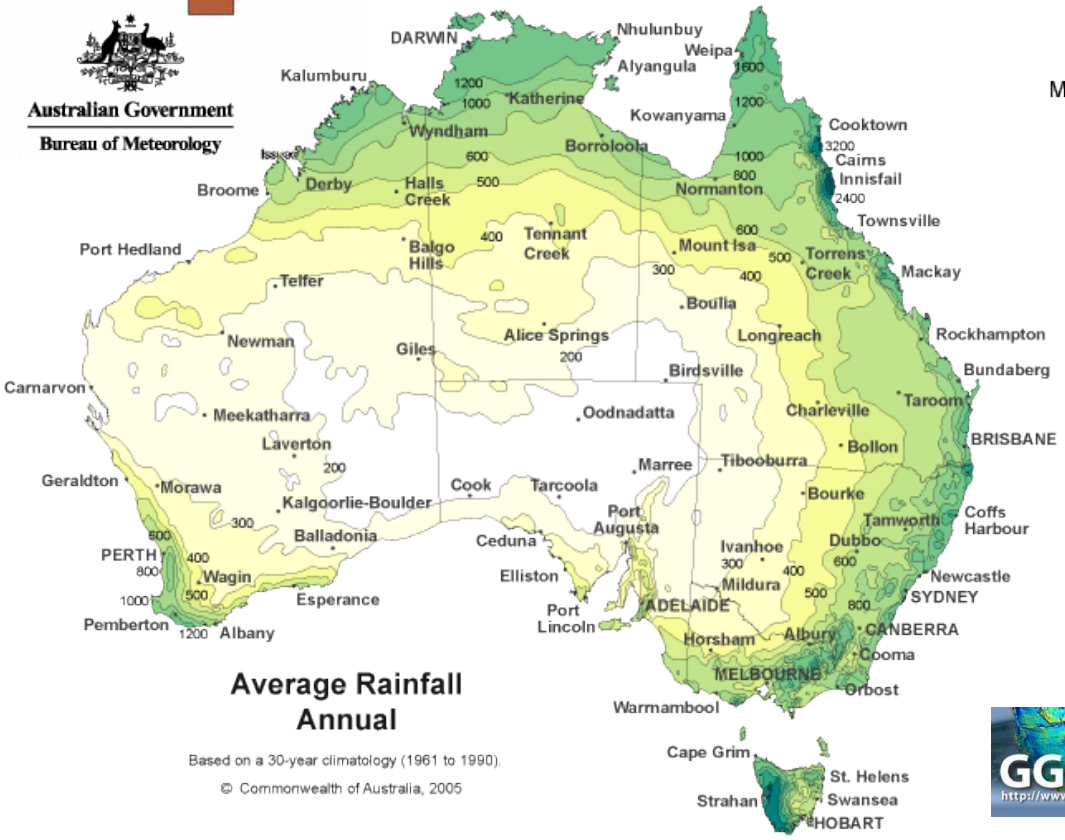
- Examination of whether a third SLR laser site in northern Australia (colocated with VLBI near Katherine) is necessary in order to meet the long-term accuracy goals:
  - For Australian reference frame, and
  - As a contribution to the global reference frame

Cost of construction and operation of laser station in remote area is high and will need good reasons!

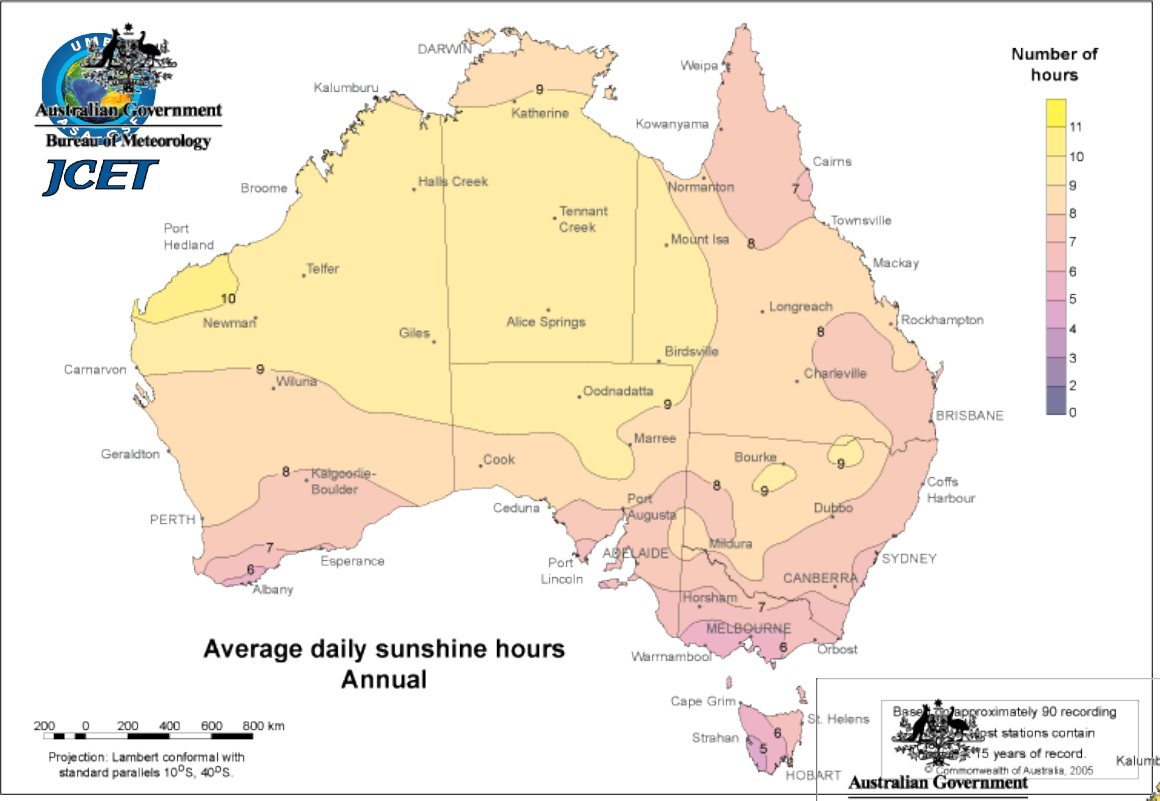
AuScope







QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.


Australian Government
Bureau of Meteorology
JCET
Number of hours
11
10
9
8
7
6
5
4
3
2
0
DARWIN
Kalumburu
Katherine
Weipa
Kowanyama
Cairns
Broome
Halls Creek
Normanton
Tennant Creek
Townsville
Port Hedland
Mount Isa
Telfer
Mackay
Newman
Alice Springs
Longreach
Rockhampton
Giles
Birdsville
Carnarvon
Charleville
Wiluna
Oodnadatta
BRISBANE
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Geraldton
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Bourke
Coffs Harbour
Kalgoorlie-Boulder
Port Augusta
PERTH
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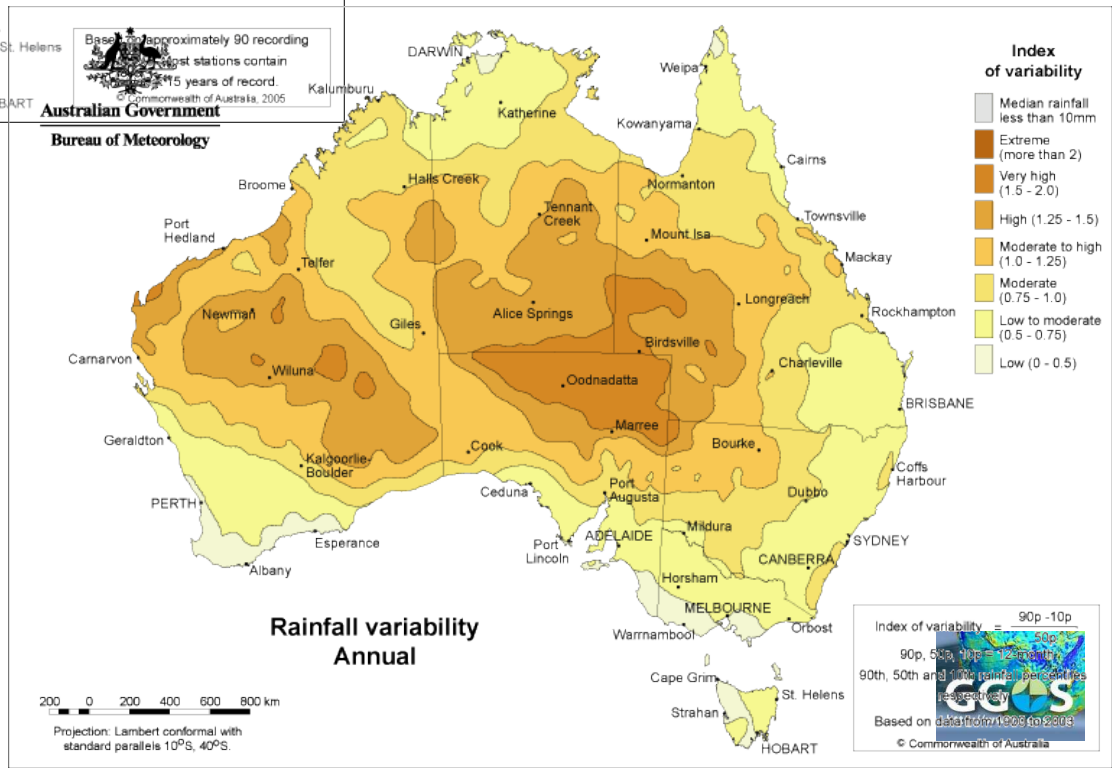
Esperance
Mildura
ADELAIDE
SYDNEY
Port Lincoln
CANBERRA
Albany
Horsham
MELBOURNE
Warrnambool
Orbost
Cape Grim
St. Helens
Strahan
HOBART
200 0 200 400 600 800 km
Projection: Lambert conformal with standard parallels 10°S, 40°S.
Average daily sunshine hours
Annual


Based on approximately 90 recording stations contain 15 years of record.
© Commonwealth of Australia, 2005
Australian Government
Bureau of Meteorology
Index of variability
Median rainfall less than 10mm
Extreme (more than 2)
Very high (1.5 - 2.0)
High (1.25 - 1.5)
Moderate to high (1.0 - 1.25)
Moderate (0.75 - 1.0)
Low to moderate (0.5 - 0.75)
Low (0 - 0.5)
DARWIN
Kalumburu
Katherine
Weipa
Kowanyama
Cairns
Broome
Halls Creek
Normanton
Tennant Creek
Townsville
Port Hedland
Mount Isa
Telfer
Mackay
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Longreach
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CANBERRA
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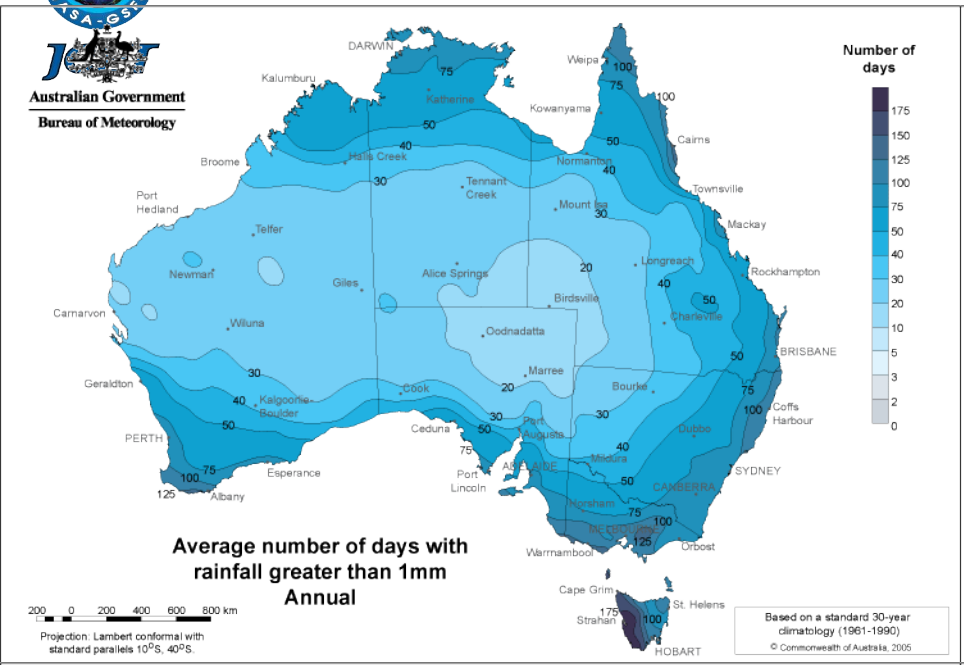
MELBOURNE
Warrnambool
Orbost
Cape Grim
St. Helens
Strahan
HOBART
200 0 200 400 600 800 km
Projection: Lambert conformal with standard parallels 10°S, 40°S.
Rainfall variability
Annual
Index of variability = 90p -10p / 50p
90p, 50p, 10p = 12 monthly 90th, 50th and 10th rainfall percentiles respectively
Based on data from 1900 to 2005
© Commonwealth of Australia


Australian Government
Bureau of Meteorology
Number of days
175
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125
100
75
50
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Kalumburu
Katherine
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Cairns
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Port Lincoln
CANBERRA
Albany
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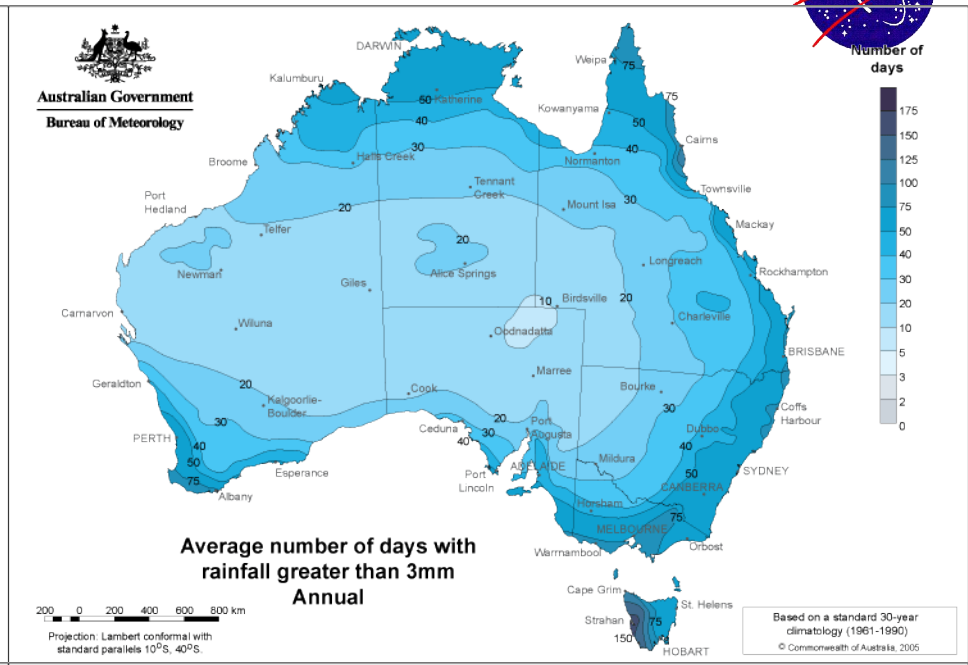
MELBOURNE
Warrnambool
Orbost
Cape Grim
St. Helens
Strahan
HOBART
200 0 200 400 600 800 km
Projection: Lambert conformal with standard parallels 10°S, 40°S.
Based on a standard 30-year climatology (1961-1990)
© Commonwealth of Australia, 2005
Average number of days with rainfall greater than 1mm
Annual


Australian Government
Bureau of Meteorology
Number of days
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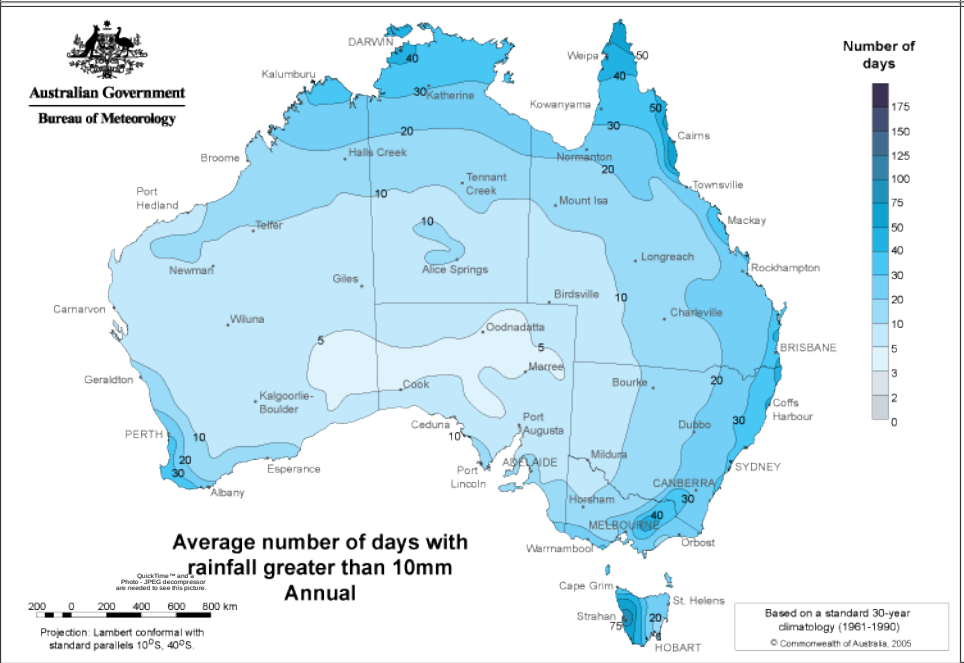
Strahan
HOBART
200 0 200 400 600 800 km
Projection: Lambert conformal with standard parallels 10°S, 40°S.
Based on a standard 30-year climatology (1961-1990)
© Commonwealth of Australia, 2005
Average number of days with rainfall greater than 3mm
Annual


Australian Government
Bureau of Meteorology
Number of days
175
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DARWIN
Kalumburu
Katherine
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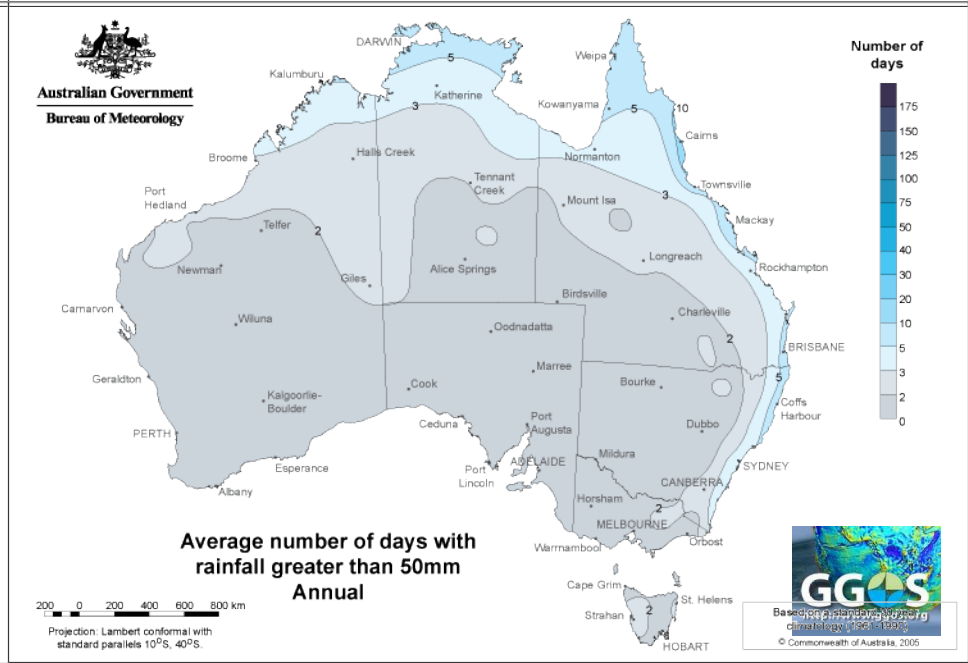
HOBART
200 0 200 400 600 800 km
Projection: Lambert conformal with standard parallels 10°S, 40°S.
Based on a standard 30-year climatology (1961-1990)
© Commonwealth of Australia, 2005
Average number of days with rainfall greater than 10mm
Annual


Australian Government
Bureau of Meteorology
Number of days
175
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DARWIN
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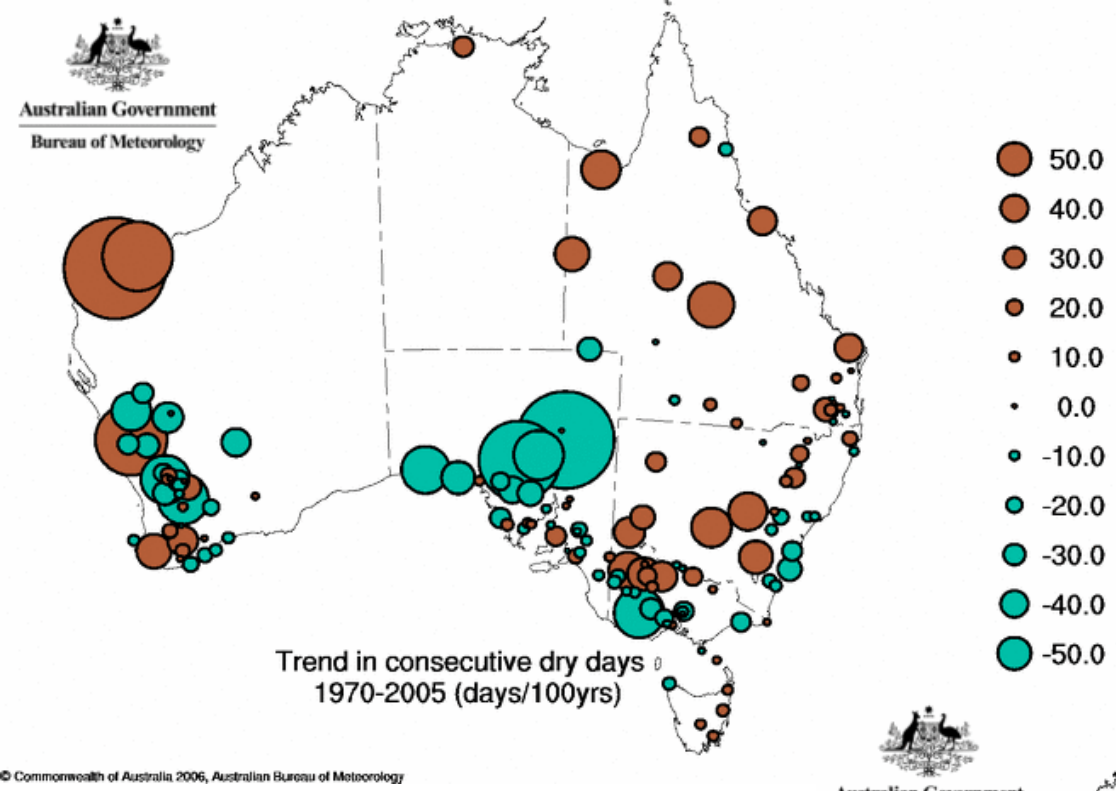
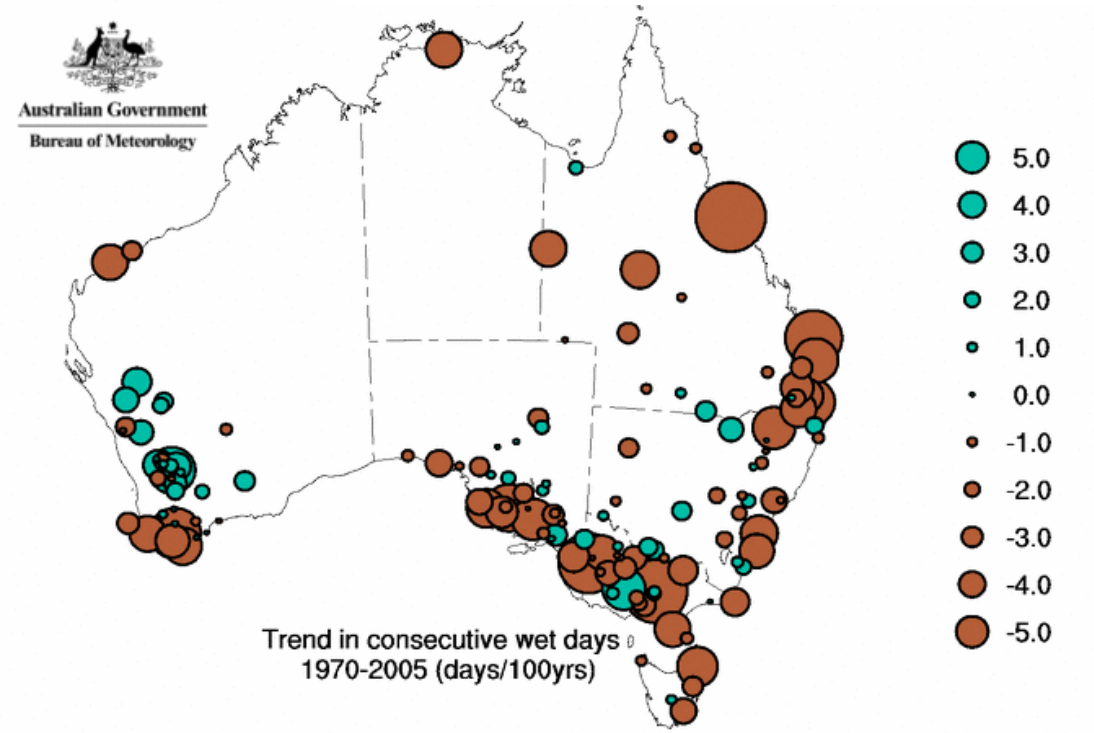
Orbost
Cape Grim
St. Helens
Strahan
HOBART
200 0 200 400 600 800 km
Projection: Lambert conformal with standard parallels 10°S, 40°S.
Based on a standard 30-year climatology (1961-1990)
© Commonwealth of Australia, 2005
Average number of days with rainfall greater than 50mm
Annual





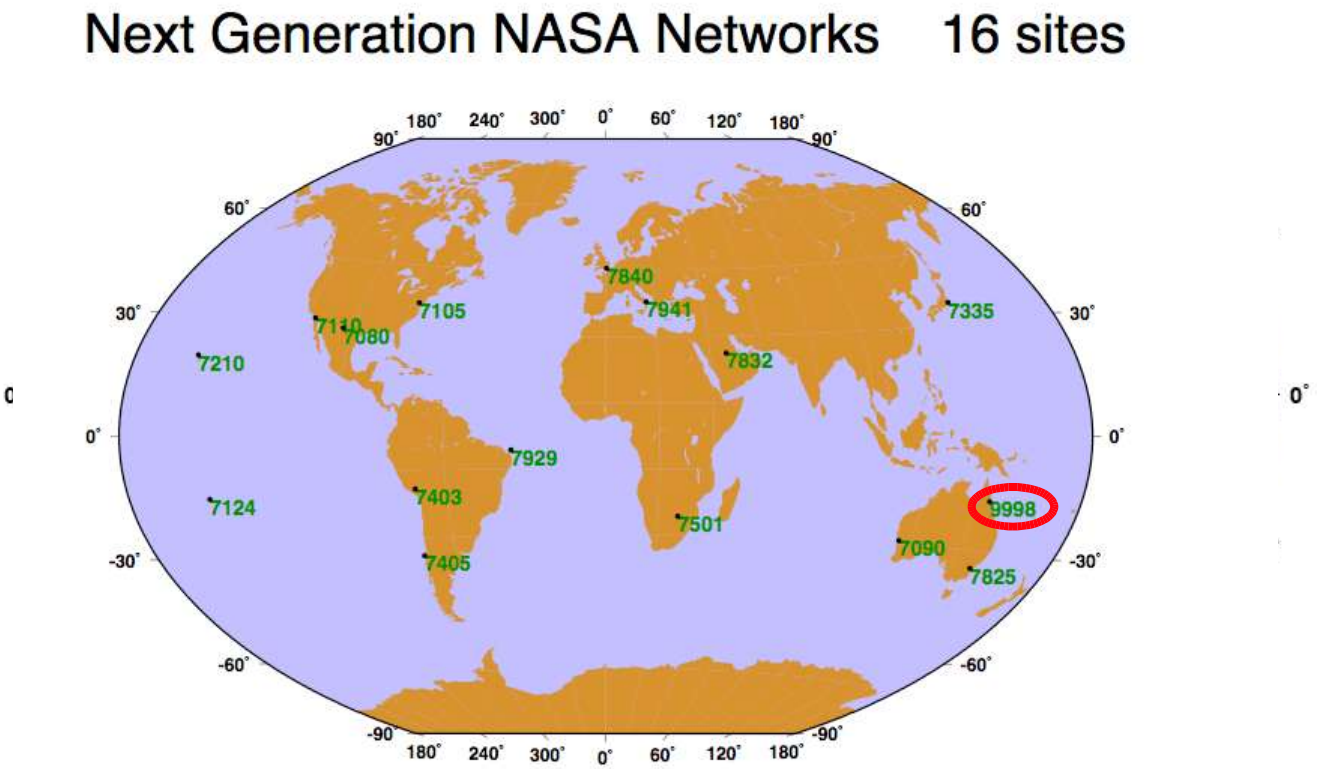
Issued: 27/10/2006

Studies for TRF Contribution

- Two approaches:
  - Covariance studies with Monte Carlo runs
  - Simulation of SLR and VLBI data for:
    - the existing network
    - the existing network PLUS VLBI at Yarragadee and Katherine
    - the above PLUS a SLR co-located with the VLBI at Katherine
  - SLR@KATH operating similar to Mt. Stromlo

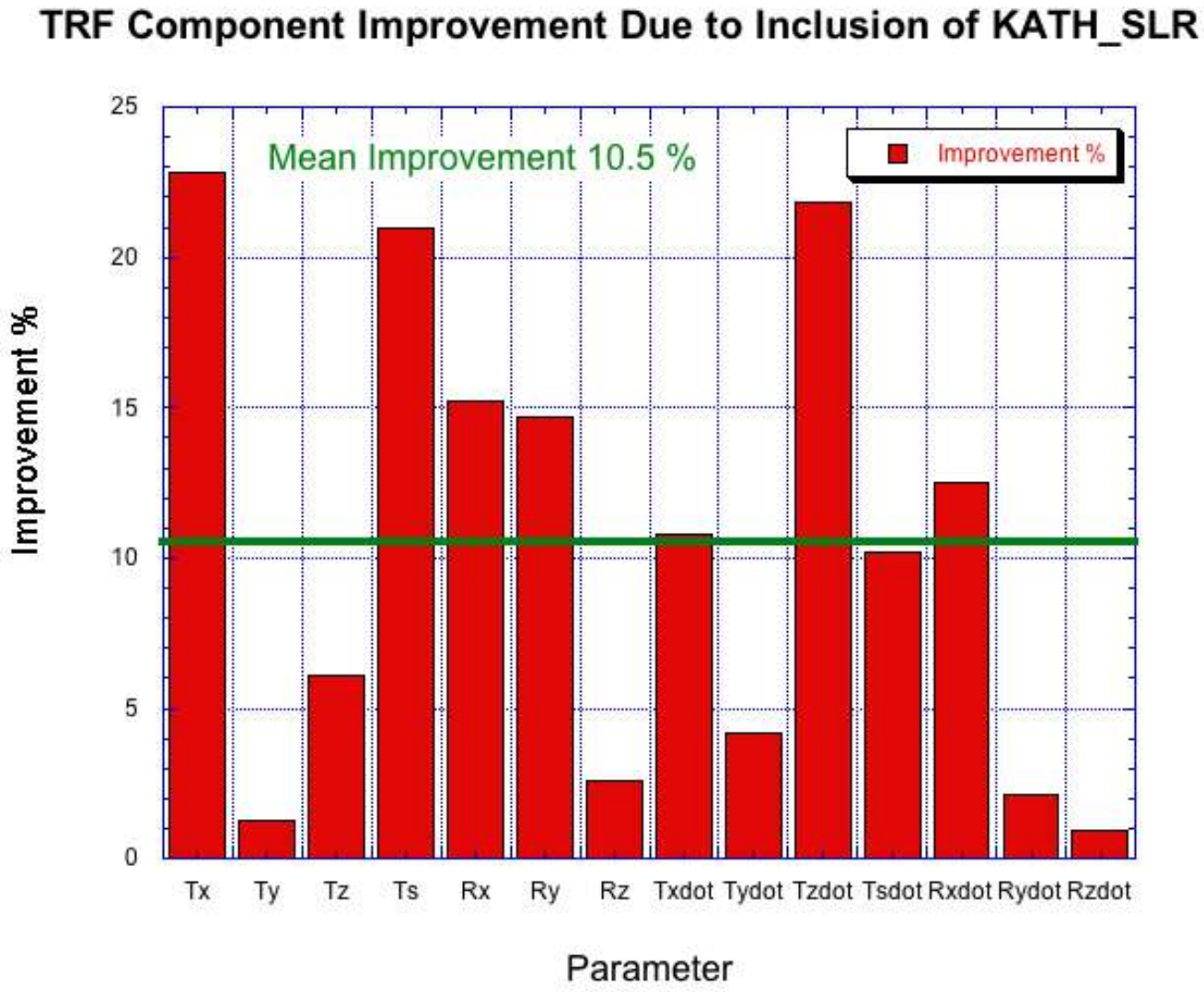
SLR addition at KATH

KATH co-location of SLR-VLBI will add much-needed dual site in an area void of such and will strengthen the eastern hemisphere ties for these two techniques



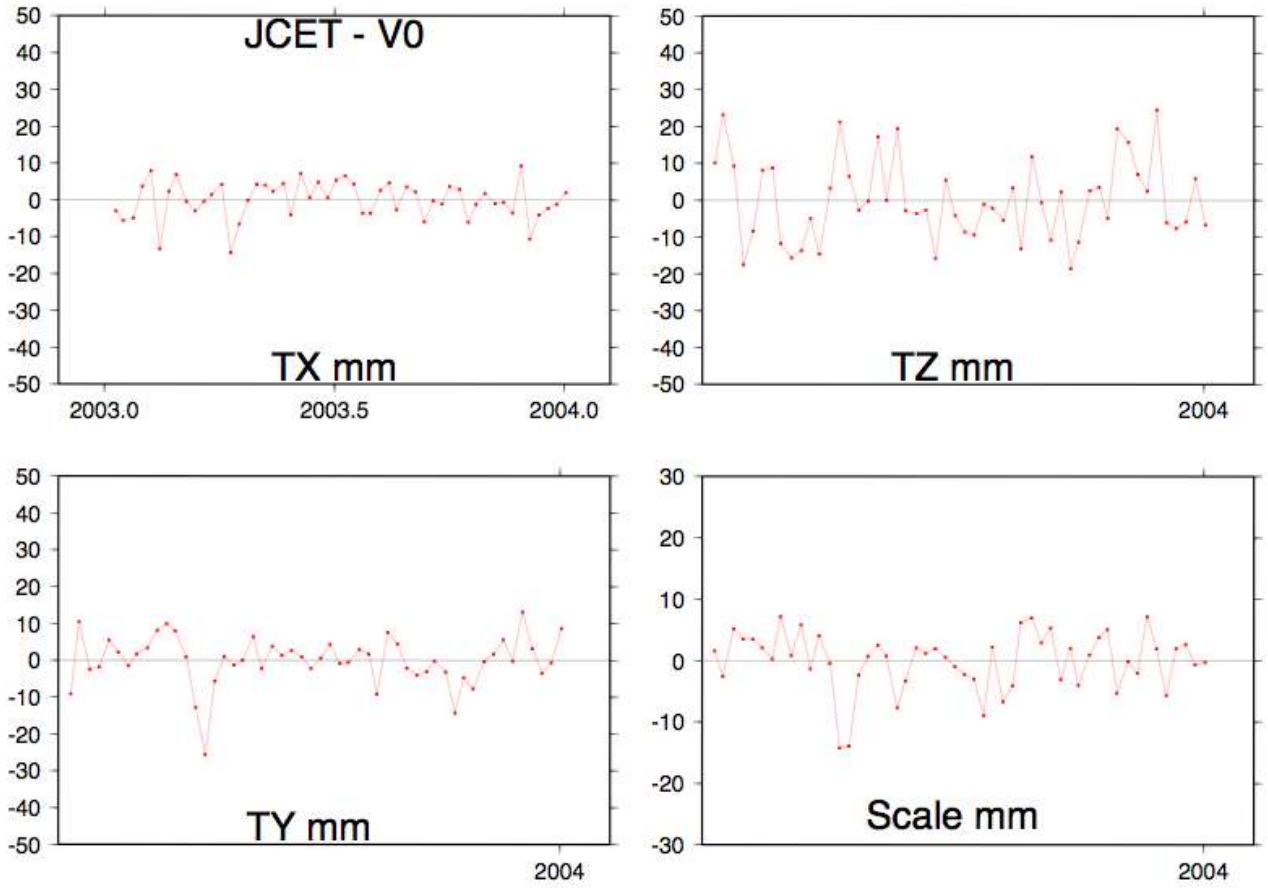
SLR @ KATH

Monte Carlo - predicted covariance



One Year Simulation (2003)

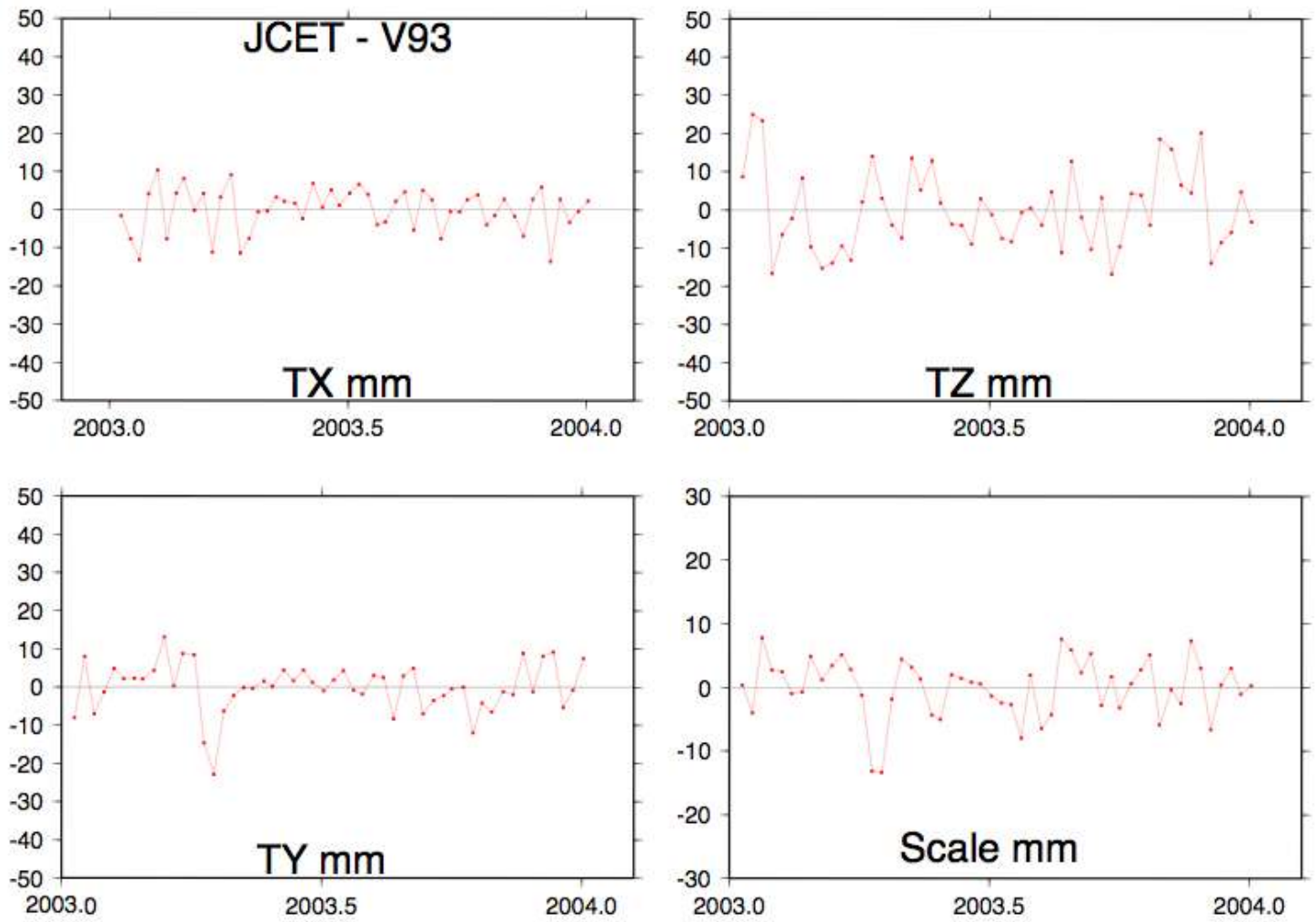
Standard SLR network simulated data reproduce the origin and scale variations observed with real data:



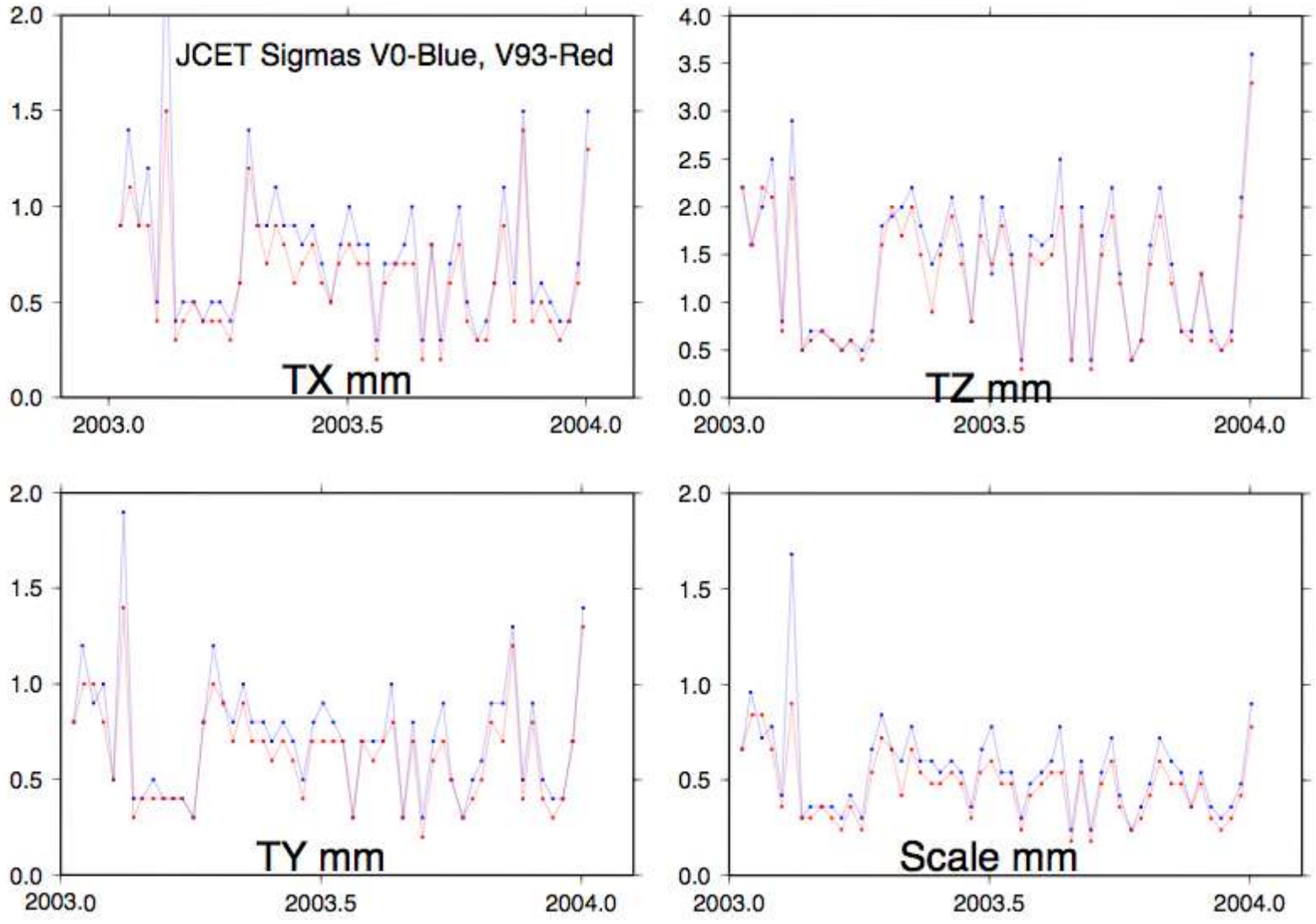
QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

Addition of SLR@KATH

- As expected, addition of one site does not change dramatically the results:

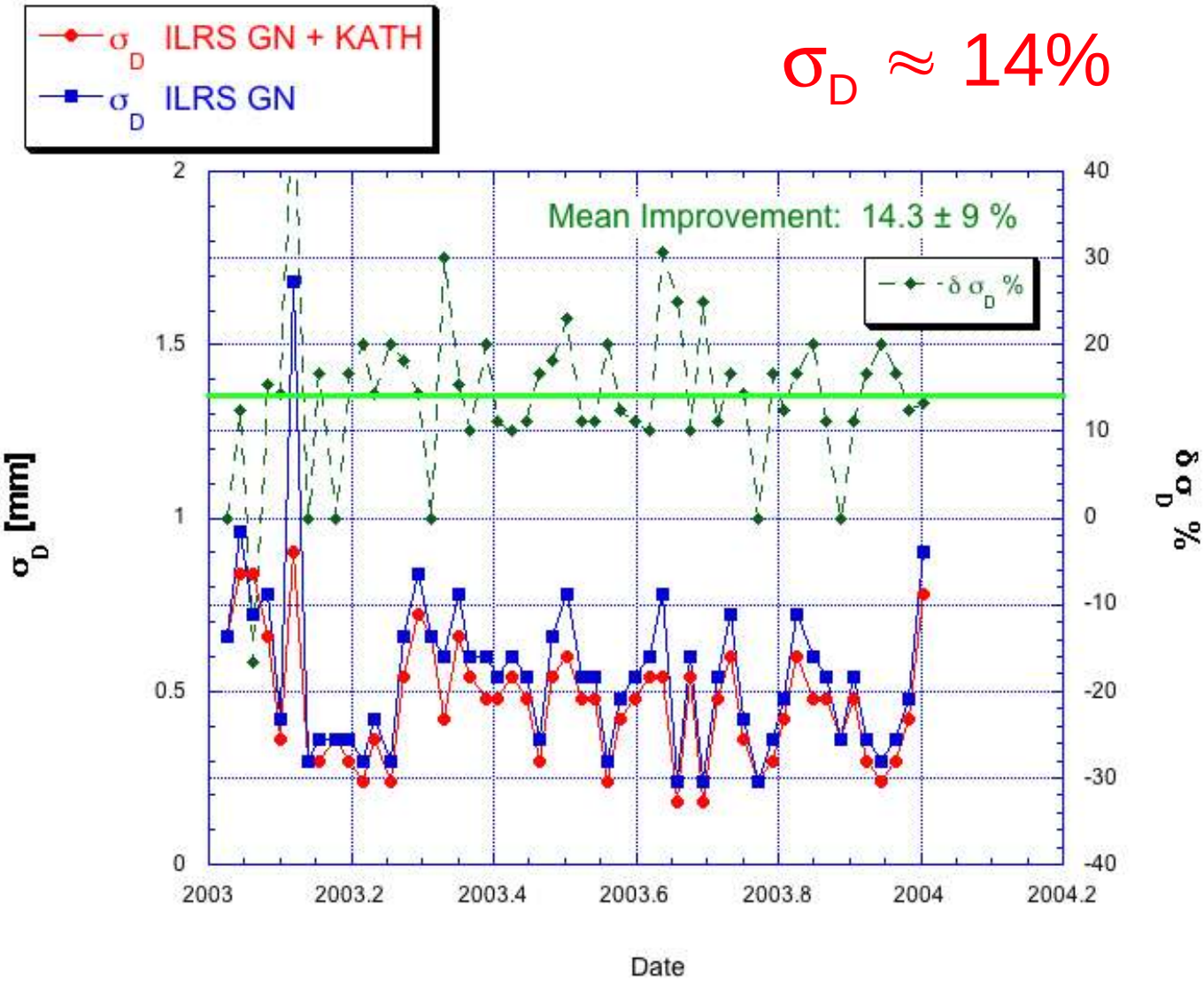


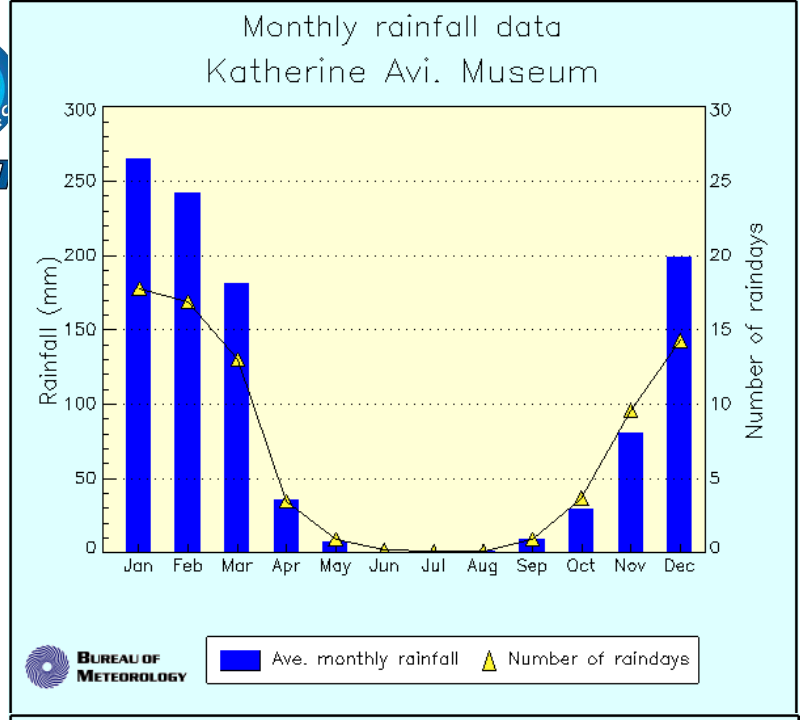
Change in Error Estimates

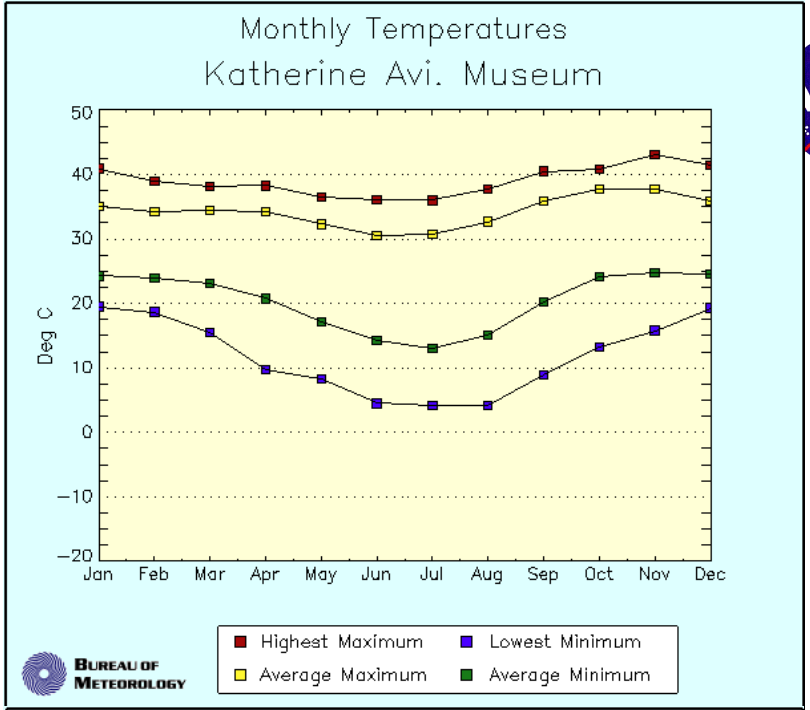


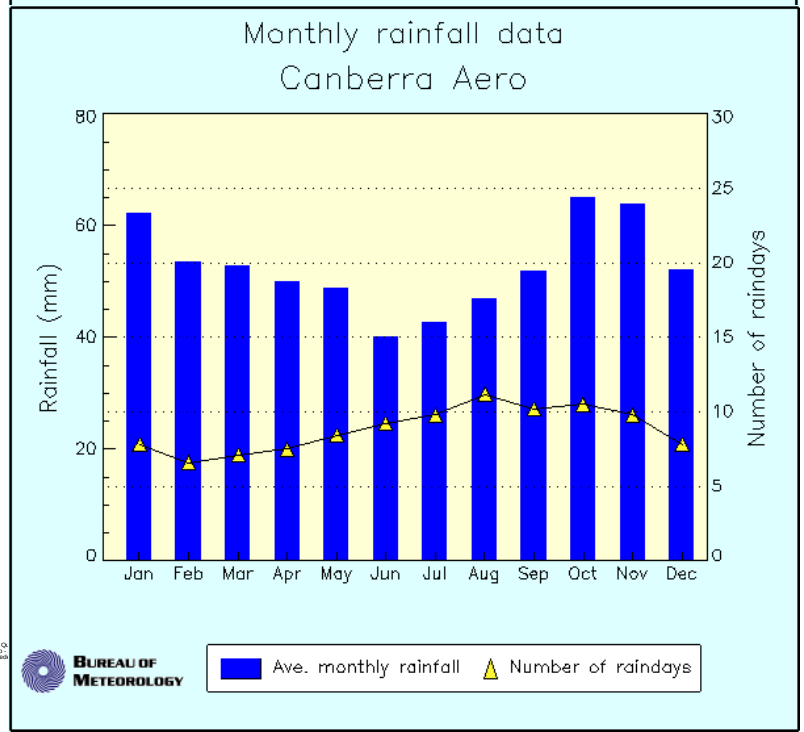
Change in scale σ due to SLR@KATH

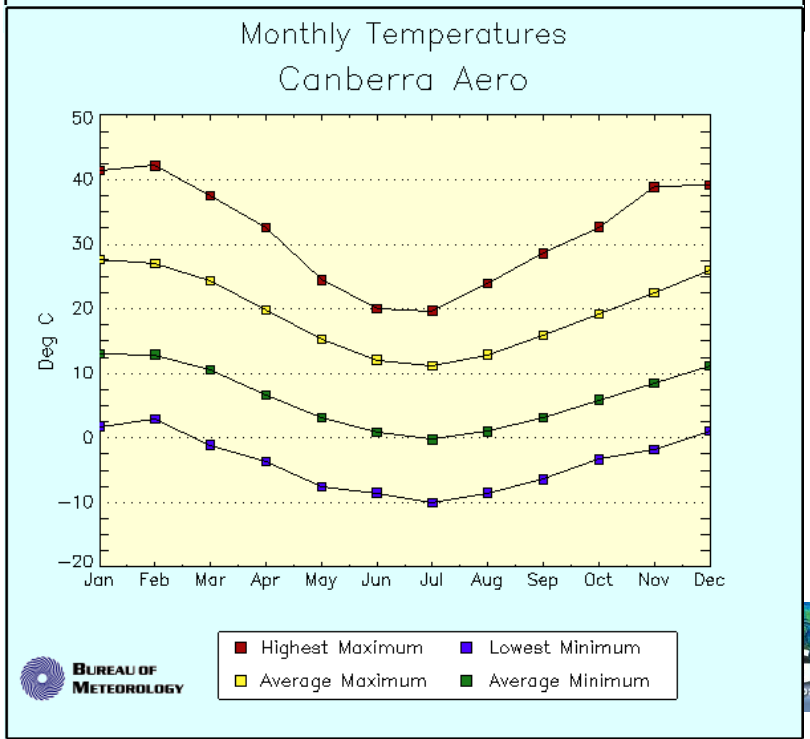
$\sigma_D \approx 14\%$




Monthly rainfall data
Katherine Avi. Museum
Rainfall (mm)
Number of raindays
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Bureau of Meteorology
Ave. monthly rainfall
Number of raindays


Monthly Temperatures
Katherine Avi. Museum
Deg C
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Bureau of Meteorology
Highest Maximum
Lowest Minimum
Average Maximum
Average Minimum


Monthly rainfall data
Canberra Aero
Rainfall (mm)
Number of raindays
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Bureau of Meteorology
Ave. monthly rainfall
Number of raindays


Monthly Temperatures
Canberra Aero
Deg C
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Bureau of Meteorology
Highest Maximum
Lowest Minimum
Average Maximum
Average Minimum

Summary

- Initial results show that SLR@KATH is a significant contribution to the current global SLR@VLBI sub-network
- Covariance analysis indicates that over the long term, there is significant contribution to be expected in the rate of Tz, something that requires the simulation of several years of data
- Selecting KATH as one of the “future” sites for the NGN simulations will allow us to verify this from the decadal simulations
- Selection of an alternate site at Mareeba (west of Cairns) alleviates concerns about weather conditions at Katherine while it does not change the simulation results appreciably.